Progress with the COGENT Edge Kinetic Code

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COGENT is a continuum gyrokinetic code for edge plasmas being developed by the Edge Simulation Laboratory collaboration. The code is distinguished by application of 4th order conservative discretization, and mapped multiblock grid technology to handle the geometric complexity of the tokamak edge. It is written in $v_{||}$, μ velocity coordinates, and uses the gyrokinetic Poisson equation for the calculation of a self-consistent electric potential. Verification tests investigated the collisionless damping of the geodesic acoustic modes (GAMs) and demonstrated very good agreement with analytical predictions. Our recent development work has focused on the incorporation of collision operators, adding a radial diffusion operator to qualitatively simulate the effects of turbulent transport, and upgrading to include divertor geometry (i.e., a simulation domain that includes closed and open flux surfaces and a magnetic separatrix). We have added a succession of increasingly detailed collision operator options, including a simple drag-diffusion operator in $v_{||}$, Krook collisions, Lorentz collisions, and a linearized model Fokker-Planck collision operator conserving momentum and energy. Based on the generalization of the linearized operator we have also formulated a model nonlinear collision operator for the case where a distribution function is nearly isotropic, but arbitrary in speed. We have performed a number of verification tests of these operators, including recovery of analytic results for loss over a prescribed potential barrier, neoclassical fluxes, and the collisional-timescale self-consistent radial electric field. Work in progress includes recovery of the effects of a large radial electric field on the neoclassical flow velocities and on the rate of GAMs relaxation.

We are concurrently making rapid progress toward development of a divertor version of the code. The key piece of new technology we exploit, recently released in our underlying Chombo framework, is a mapped multiblock capability, whereby the closed-flux-surface edge, scrape-off-layer, and private-flux regions of a tokamak are described by separate blocks of grids which communicate through their common boundaries. The initial testing of the divertor version of the code is currently underway.

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